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In a former article, "On the Homologies of the Molar Teeth," etc., I traced the modifications of the superior and many of the inferior molars of the ungulate mammals to a parent quadrituberculate type. In a subsequent essay* I traced the origin of the inferior sectorial to a primitive five-tubercled, or "tubercular sectorial" type. Farther than this I did not go, and made no attempt to derive the few cases of triangular superior molars then known, nor the type of the superior sectorial. The revelations of the Puerco fauna show, that the superior molars of both ungulate and unguiculate mammalia have been derived from a tritubercular type; and that the inferior true molars of both have been derived from a "tubercular sectorial" type. Shall we look for the origin of the latter in a tritubercular tooth also, *i.e.*, tubercular sectorial without heel; and will the crowns of the true molars of the primitive mammals alternate with, instead of oppose each other? This is a probable result of future discovery.

On the Synchronous-Multiplex Telegraph. By Prof. Houston.

(Read before the American Philosophical Society, December 7, 1883.)

Prof. Houston said: "It is with considerable pleasure, Mr. President and gentlemen, that I am here this evening to call your attention to a discovery in electricity that appears to me to be of very great practical value to the world. The present decade has witnessed such marvelous progress in electrical inventions that many of us have perhaps been disposed to believe that but little new could reasonably be expected, but, unless I am greatly mistaken, the invention which I am about to describe to you, is greater even than that of the telephone.

"Before proceeding to the details of the invention of the synchronous-multiplex telegraph system of Mr. Patrick B. Delany, it will, perhaps, be best that your attention should first be called to some of the practical purposes for which it is applicable. Briefly stated, the value of this invention is to be found in the fact, that by its use the simultaneous transmission of numerous telegraphic dispatches over one and the same wire is readily accomplished. Hitherto, the only system that accomplished this, to any considerable extent, in actual practice, was the quadruplex system, and this, as you well know, is not only limited to the simultaneous transmission of four dispatches, but these are necessarily sent, two each, in opposite directions. You will, therefore, readily understand the great value of Mr. Delany's wonderful invention, when I inform you that not only can the number of simultaneously transmitted dispatches be very greatly increased, even indeed as far as seventy-two, but that all of them can be sent in the same direction, or any part in one direction and the remainder in the opposite direction.

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*Journal Academy Natural Sciences, Philadelphia, March, 1875.

"It would be difficult, on the eve of an important discovery like that we are discussing, to predict the extent and nature of the effect its practical introduction will have on the world at large; but this I think will appear evident, that the synchronous-multiplex telegraphic system will do for the most distant cities of our country, what the telephone has done for the inhabitants in the same city, or for those of neighboring cities, with, however, this difference, that in the case of the synchronous system, a permanent record is obtained of all dispatches sent or received, while in the telephonic system of transmission there is none.

"Without, however, seeking to look further into the future, let us pass to the descriptions of the details of this remarkable invention.

"The multiplex system differs radically from the quadruplex, which, as you are probably aware, is based on the balancing of resistances, or the differential method. The multiplex system, on the contrary, is based on the synchronous rotation of two trailing contact arms which are connected to the ends of the line, one at each end of the main line. Series of contacts, on the face of discs, swept by the trailing arms, are in electrical connection with the various operators that desire to use the line. By the rotation of the arms, the main line is brought successively into electrical contact with each of the operators, and carried from one to another, and again given back to each successively, so rapidly, that before any of them can realize that he has been disconnected from the line, it is again given to him, so that the line is at his disposal, to the same extent as if he alone was using it.

"The appliances whereby Mr. Delany maintains practically absolute synchronism in the revolving arms at each end of the line are of remarkable simplicity. A few of the contacts before referred to, as being placed on the face of the discs, are reserved for the maintenance of synchronism. Some of these contacts are connected to a battery and others to correcting devices at each end of the line, while others are left open or unconnected with anything. If the synchronous rotation of the two arms is maintained, no correcting impulses pass over the line, since, although one end thereof is in electrical connection with one of the batteries, the other end is on an unconnected segment, and the battery circuit being open, no current flows; should, however, the line at one end be brought in contact with a part of the disc, very slightly in advance of its position on the disc at the other end, then the battery is connected, and an electrical impulse flows over the line, and slows the rotation of the arm.

"The manner in which this correcting impulse is made a retarding one is as follows: the rotation of the trailing arm at each end of the line is maintained by an electric magnetic device, invented by LaCour, of Copenhagen, and termed by him a phonic-wheel. The rapidity of rotation of this wheel is dependent on the rapidity with which an electrical current traversing the coils of its electro-magnet, is made and broken.

"The makes and breaks in the circuit of the motor-magnet of the phonic-wheel, are governed by the vibration of a tuning-fork, maintained in its vibration by the action of a voltaic battery. Since the rate of vibration of the fork governs the rate of rotation of the arm, it is only necessary to maintain the synchronous vibration of two forks, placed at each end of the line.

"Although the duration of vibration of a fork, like the oscillation of a pendulum, is sensibly the same for all amplitudes, provided the amplitude is very small, yet, as you are aware, the duration becomes longer, or the vibration slower, if the amplitude of the oscillation be very sensibly increased. Now the inventor obtains the requisite slowing of that fork's vibration, that is connected with the phonic-wheel that has gained on the other, by causing the electrical impulse that flows over the line to increase the strength of the electrical current that is traversing the battery circuit that is keeping it in vibration. This he accomplishes by cutting a resistance out of this circuit, and thus allowing more current to pass.

"In order to avoid the disturbance produced by the static charge, that is generally found in long lines, the inventor has provided a series of extra contacts, placed between each of the separate contacts that, at each end of the line, are connected to the transmitting or receiving instruments. These extra contacts are connected together and to the earth, so that when the line is disconnected from one instrument, it is put to the earth before it is given to the next instrument, and is thus completely freed from its static charge. These discharge contacts are absolutely necessary to the successful operation of the synchronous system, where the length of line employed is extended.

"Since the circuit of any operator is constantly made and broken, as often as the line is taken and again returned to him, the use of an ordinary Morse relay would be inapplicable in the practice of this system, since all the impulses (a number of which make up a single character, as well as the characters sent into the line from the transmitting key of the operator connected) would be recorded. In order to avoid this confusion the transmission battery is split and grounded in the middle, and polarized relays substituted for the ordinary instruments. Since these relays respond, not to makes and breaks in the circuit, but to changes of polarity only, the receiving instruments are influenced only by the characters sent by the operators, and not by the successive makes and breaks.

"The successful solution of the problem of maintaining synchronism by the methods I have explained, render many things possible that without it would have been impossible. Among these I may mention the various applications of fac-similies, and autographic telegraphs. Without attempting to go into the details of their application, it will suffice to say that the probable applications of Mr. Delany's system are so numerous and important, as to entitle him to a very high rank among the world's inventors."